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WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Western Foundrymen's Association was held Wednesday evening, July 21, 1897, at the Great Northern Hotel, Chicago, Ill. The President, Mr. C. A. Sercomb, occupied the chair.

The Secretary reported that at the last meeting of the Board of Directors a motion was made that the name of Mr. Thomas D. West be presented at the next meeting of the association for honorary membership. On motion, duly made and seconded, Mr. West was unanimously elected to the same.

The following paper, contributed by H. F. Frohman, was then read by the Secretary:

FOUNDRY FACINGS.

Something is needed in a foundry that will prevent the sand of the mold from being burned by the molten metal, that will cause the castings to "peel" readily, that will deliver the castings "smooth," from the mold with a "slick" surface and a bright color, something that will neither run nor burn away before the molten metal at the time of pouring; something that will adhere to the surface of the mold and "part" and "peel" the sand well when the casting is to be shaken out; something of such a nature

that it can be smoothed or slicked in the finishing of a mold. This something we term foundry facing—a material of a very refractory nature that will stand any amount of heat (more than the temperature of the molten metal). I fully understand that all facings are not necessarily to be slicked. Some facings are only to be dusted on the mold, but I am now speaking generally of the requirements of a good facing. The something that will do all this is carbon (in some chemical form or other), of a very refractory nature, that will stand any amount of heat. Before I proceed, please understand me that facings are not cures of all evils and ails in a foundry, for good sands as well as good molders and the use of good common sense are as essential as good facings and blackings. These latter merely assist the former.

The most common facing (which is a misnomer as it should be termed a "mixer") is sea coal or coal facing. This is used in almost every foundry. This is the only facing known which is not put on the face of the mold, but is mixed with the sand in the proportions of one shovel full of coal to 10 or 20 shovels full of sand, according to the size and weight of the casting to be made. This sea coal or crushed coal is mixed with the sand nearest to the surface of the mold, in order to "rot," or in other words to break up, the particles of sand, so that when the molten metal comes into the mold, in its heated state, it does not fuse the sand to a hard mass similar to glass, but allows the sea coal to burn away and leaves the sand in a separated condition, so that when the casting is cooled off, these particles of sand will separate and drop off. Perhaps I do not make myself as clear in this explanation as I should, but this can be verified by putting a small quantity of silica sand in a heated vat so that the temperature will just about fuse the sand. Notice how it will melt together into a solid mass. Then try the same amount of silica sand with a certain percentage of coal dust. You will then notice it requires twice the amount of time and almost twice the amount of heat to accomplish the same result. There is another reason why sea coal is mixed with the sand. This is to vent the mold and allow the gases to escape. Sea coal facing is made from the

very best quality of soft or bituminous coal, containing neither slate nor phosphorus, but high in hydro-carbon gases and volatile matter; and the best gas coal makes the best sea coal facing. As stated previously, this is the only kind of facing that is mixed with the sand. All the others are either dusted on the mold or applied with the hand or brush, used wet or dry as the class of work requires. Not only is sea coal necessary to produce a good and sound casting, but a facing or blacking is needed that will close up the pores of sand on the face of the mold so as to produce a smooth surface, and also to a certain extent pave the way so that the molten metal will have an easy glide and at the same time overcome as much resistance as possible and not in any way retard the flow, but on the contrary help it along to find its proper resting place and prevent any of the sand from clinging to the casting after it has been shaken off. The facing must be of high carbon, so as not to burn away, but to remain on the surface of the mold and act as the separator between iron and sand. The best grade of separator (if we are allowed to use that name) is what we term plumbago, silver lead or graphite. These three names mean essentially one and the same thing. Strange as it may seem to the enllghtened citizens of this country, a great ignorance exists as to the nature and uses of this material. While speaking of this I desire to correct the rumor that it is dangerous to inhale plumbago or black lead, as it is commonly known. It is not a lead but a carbon almost pure, or a pure coal, the diamond being its most perfect specimen in the crystalized state.

Probably the best grade of plumbago in its crude state is found in the Island of Ceylon, among the East India Islands. A fair quality is also found in New York State; but the greater part of the facings used in this country are made from the Ceylon grade. The crude plumbago is mined and carried from the mines in its crude state by the natives in baskets to above the ground; here it is separated, the lumps in one pile, chips and dust in another. It is then put up in large barrels or hogsheads and sent to this country in sailing vessels as ballast. The manufacturers receiving it in this manner, refine, reduce, pulverize and

mix it to suit the various classes of work for which it is intended. This Ceylon plumbago being purer, richer, of a more particular nature, is best adapted for facing purposes. Unlike any other carbon or even graphite used for foundry purposes a pure and good grade of plumbago can be used for almost any kind of molding, such as dusting, putting on the mold with a brush, in dry sand or green sand work, or for core wash, either painting the cores or dipping them. This is probably the best facing to use and the foundrymen and molders are realizing this generally. In former years pounds were used while we might say tons are consumed at present. A pure plumbago is not affected by heat, cold or acid, and, on account of its greasy nature, acts as a sort of lubricator in the mold, helping the iron to find its proper resting place. In making stove plate castings and other light work which is very thin, an extremely smooth surface is required. Two facings are necessary for the finishing of a mold. A first or heavy facing to fill up the pores of the sand and a second or light facing to make a good print or impression on the surface of the mold and at the same time to prevent the heavy or first facing sticking to the pattern (thereby saving the mold from being disturbed), to assist in peeling the casting and lastly to give the casting its proper color. You will understand that stove plate castings are made so light and thin nowadays that any defect in molding could be easily seen, and therefore would make the castings useless for the purpose intended. Other castings might be plugged or filled, but stove plate cannot. The heavy facing used in stove plate molding is usually made from an extremely heavy carbon or graphite, while the light facing is a combination of charcoal and coke, etc., or lighter carbons. The heavy facing is to withstand the heat of the iron, while the lighter prevents the former from curling up or running before the iron and also prevents the mold from being disturbed and also gives the casting the desired color.

Besides the foregoing there are a number of different kinds of facings for different kinds of work, such as a soapstone facing (which, by the way, is the only facing known, not of a dark color).

This soapstone is used for hollow ware and other light castings and is also used by foundrymen generally to mix with plumbago in order to cheapen it. In feeling, soapstone is of a greasy nature similar to plumbago, but soapstone cannot be used to any advantage by itself, but is applicable for general work if mixed with blackings. Soapstone facing used on the mold produces a light-colored casting with the appearance of having been whitewashed.

In former years before the foundrymen used such quantities of imported plumbago, a certain Rhode Island facing was the standby and was supposed to be the cure for all evils in the foundry. It was used considerably then for all classes of work, but it has been supplanted by something better. Its nature was similar to plumbago, but not nearly as rich or pure. Its greatest drawback was that it was too "sticky" and that it would not "slick." But as the facing business has advanced, this Rhode Island facing has become a thing of the past and is now succeeded by those of higher grade and qualities.

Mineral facing, X, XX, XXX, XXXX, and as many more X's as you want to add, is made from a graphite coal and is used on general work in a foundry when a particularly smooth surface is not required, merely dusted on to save the casting-cleaner labor. This mineral facing in its different forms is used in car wheel foundries where it is essential and a good mineral facing is necessary. At the present prices ruling for car wheels and general car castings, foundrymen advise us that they cannot purchase as expensive blacking for this purpose as they could formerly, so it has been left to the facing manufacturers to produce a mineral facing at a minimum cost that can be dusted on the mold (not necessary to be "slicked"), that will prevent the iron from cutting into the sand, that will not affect the chill in any way, that will not burn away but bring out the casting free from the sand when shaken out.

There are many more different kinds of facings and blackings for the different kinds of work, and each and every manufacturer classes them according to his notion and pocketbook, but I have

mentioned the principal ones, probably with the exception of pipe blacking. This requires a special blacking containing no impurities whatsoever, and extremely rich in carbon. In putting cast iron pipes to a hydraulic test impure or inferior blacking will show its results more than in any other class of iron founding. The blacking used in pipe foundries is subjected to a chemical analysis before its acceptance for this purpose.

Under foundry facings we might embrace blackings for dry sand work, but as that is almost a separate study of the business, I would prefer leaving it to some future time for discussion. However, I will refer to this class in a few words. For dry sand work, as well as painting cores, about the same ingredients are used as for dusting, only mixed in a different manner and such other ingredients added as will not dissolve in water but assimilate with it very easily. In mixing a blacking for a wash it should be mixed very carefully and worked just as our mothers made up their dough in making bread. Add a little blacking, then water, then blacking, then water, until you have secured the consistency wanted. If this blacking is so mixed it will be found to give much better satisfaction and at the same time save the molder and the casting-cleaner much annoyance.

Facings and blackings should always be kept in a dry place. As a rule they absorb more or less dampness and if they are damp they cause any amount of unnecessary trouble to molders, the result of which no doubt all of you have experienced. I have noticed time and again that if a casting is lost, first the facing is blamed, then the sand, etc., but never the molder. For the benefit of foundrymen in general, I desire to state that a facing and blacking will always show its defect in ways that can easily be traced. If of poor quality it will run or burn away, when the molten metal comes in the mold. If too much is used it will wash or run before the iron and allow the molten metal to cut deep into the sand, or if the metal is poured too hot the blacking is liable to curl up and slide into one corner of the mold. Too much sea coal used in the sand will show a mapped casting; not enough used will allow the sand to cling to the mold. Without going

into the details of manufacturing these facings or their special uses, I trust I have interested you. It is an interesting and immense subject to us.

DISCUSSION.

Mr. Carver: There is a gentleman here who makes, I believe, the best castings that are made in the northwest and I would like to hear from him and have him tell us what kind of facings he uses and how it is he gets such good results and such good stove plate castings. The gentleman is Mr. Moore, of The Joliet Stove Works.

Mr. Moore: The orator rather embarrasses me with compliments. I wish I could believe all he says, as I hope he does. I think that he rather overestimates the quality of work that we turn out, and I can assure you that what we do not know about the facing matter would be a very long story. The facings that are used in stove foundries now are generally plumbago and what are known as "heavy facings," the composition of which I really do not know. The writer of the paper could have told a great many things in that connection that he knows and that I do not. It is a mistake however, to say that the best stove plate castings are made with plumbago. The best stove plate castings that are made in this country are made east of the Hudson river, and it has been so for a generation or two and there is not very much change. The heavy facing that is used in the New England foundries is German lead and that is used in very small quantities in the west. The difficulty is in the use of it, and it seems to take an educated lot of workmen to manipulate it. The New England molders have been brought up to use German lead and they do use it and make the best castings that are made in this country. They also use Rhode Island lead. The great difficulty in using those facings where the molders have not been brought up to use them is in their stickiness.

We treat different castings differently. We use some Rhode Island lead; we use some plumbago; and we find that fine charcoal makes very satisfactory returns on most of the heavy facings We also use considerable soapstone.

Stove plate castings are made better than machinery castings, not because the foundry is better than the machinery foundry, but because all of the surrounding circumstances permit it. The sand that is used, the skill of the workman, and the various conditions that surround the work.

I would be very glad to answer any questions in detail, so far as I am able, as to how good castings are made so far as we know how to make them. We think our castings are subject to great improvement. That is our own judgment, and we would like to learn how to make them better.

It is true that a great deal more plumbago is being used on stove plates than was the case five or ten years ago, and for some kinds of plate it answers the purpose better than anything else. We meet with some conditions in stove plate castings that are not met in other castings. One is the flat gate and the difficulty of preventing cutting underneath. It takes good sand and good molding, etc., to prevent it. I wish I could give you more detailed information as to how it is done.

Mr. Carver: Mr. Moore speaks of using a heavy facing and topping it off with a lighter. What does he mean by a heavy facing; seacoal facing? And what does he mean by the lighter facing?

Mr. Moore: We do not use seacoal facings at all on stove plate. The heavy facing is either a mineral, which is sometimes an anthracite, or a combination of black lead and other things that are hardly rated in the paper. Each facing manufacturer has his own brand of heavy stove plate facing. That is the first facing that is shaken on and the return facing is a facing of charcoal and other material or charcoal alone put over the heavy facing for the purpose of making the printed back of the pattern. Without charcoal the pattern would pick up the sand from the mold. But the castings are not all made the same way. In fact I think if one were to walk through a stove shop and see the various practices in which facing is used and ask either the molders or the foreman to tell him why those things are done, he would be unable to get a satisfactory answer. One molder gets the desired result working one way and another another way.

Mr. Truesdale: I take the ground that all facings are bad. There is no such thing as a good facing. The coming foundryman will not use facings as we use them now. I am making castings for bath tubs and have been for over a year without a grain of facing of any kind and I am making better castings than I find where they are using plumbago. I do it by the use of silica sand. The time is coming when facing men will have to get into some other line of business. I have had a good deal of experience in using facings and there is so much difficulty in training men to use them properly, with any degree of judgment. A molder comes into the shop some damp, rainy morning and turns his pattern out and it sticks. It is all the fault of the facing in his estimation. It never appears to him that the conditions are different. When I first came to Chicago I found them using facings on bath tubs. The men are not used to facings and bath tubs have to have a nice enamel. I watched these fellows, who were almost all machinery molders and not accustomed to the nice use of facings. They stuck it on with trowels. There were forty places where the facing was rough. The facing was good but it was not properly handled. I have abandoned the use of facings completely and am now making better castings. I have made better work without facings than I made with them.

Mr. Ott: I have had some little experience in the use of facings. I have had my ups and downs. I feel the same as Mr. Truesdale and I hope the time is coming when we can do without facings. I think the fault is in the molder more than in the facing. I have not had much experience in stove plate castings. I have worked in stove plate shops but not in connection with the facing.

Mr. Rowlands: I can say that I have seen many times when I was very glad to have a facing. If I want to use a pattern with a real nice figure I never put on a facing. I take charcoal and shake it on the pattern. I never face it afterward. My attention was called to that in Dubuque, Iowa. We made some of the finest light castings I ever saw in my life. All they use in the world there is to shake a little coarse charcoal on the face of the

pattern. They also use it in the place of parting sand in the mold. The result is that they do not have to mold their casting over fifteen minutes and the figure is nice, bright and sharp. I think it is a good deal of a farce to use high priced facings.

Mr. Truesdale: I am accustomed to making light castings. I did not mean that the time was coming when we could make castings of twenty tons without facings. I was speaking of light castings.

Another difficulty in the use of facings is, you get the best grade of facing, what is known as Rhode Island facing, and put it in your facing box. Some fellow does not grease his pattern and it sticks. He conceives the idea of putting some return facing in with the heavy facing, or if he happens to have any soapstone around he puts in soapstone. Bill sees Jim and he thinks it is a good thing and Tom puts in a little more, and the first thing you know you have a mixture. You cannot catch them at it either.

Mr. Ferguson: I think the good and bad facing depends upon the manipulation of it. I can remember when we did not have a great variety of facings for the different kinds of work and we had to use blacking. I must say I have seen as beautiful castings made in loam with charcoal as I have seen with any other kind of facing. I cannot conceive of the time when we will make castings without the use of any facings. It may be that we will be able to get material that will answer the purpose. It would be a blessing if we could. The great trouble is with the mechanics that have to use it. They will use it 1 to 12 when they should use it 1 to 8. They do not use any judgment. One molder will bring out a fine piece of work and the one beside him will bring out a piece that you do not like to look at.

On motion, duly made and carried, the association extended a vote of thanks to Mr. Frohman for his most excellent paper.

Mr. James Frake, as chairman of the Committee on Apprentices, then submitted a report giving the legal form of indenture,

which it would be advisable to adopt. On motion the report was agreed to.

The Secretary read an invitation from the foundrymen of Cincinnati inviting the Western Foundrymen's Association to hold its October meeting in that city.

On motion, duly seconded, the invitation was accepted and it was left to the Executive Committee to arrange the plans, after which the meeting adjourned.

NEW ENGLAND FOUNDRYMEN'S ASSOCIATION.

The regular meeting of the New England Foundrymen's Association was held at Bass Point, Nahant, July 14th, 1897. After the regular business of the association had been transacted the Executive Committee furnished the members with statistics of six days' melting from various foundries, which were examined and discussed by those present.

The association had as guests Geo. S. Bullock, Massachusetts; Mr. Lyons, of Brown & Sharpe Co., Providence; Mr. Farrar, of G. W. & F. Smith, Boston; also Mr. J. A. Penton, of Detroit Mich. Owing to the inclemency of the weather a great many who had intended to be present were prevented from doing so. The meeting closed at 4 o'clock with twenty present, all of whom then adjourned to the dining room and participated in a fish dinner.

It was voted that the next meeting be held at Providence August 11th.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

AMERICAN MACHINIST.

June 1.—E. A. Gray illustrates some cast iron milling cutters used by the Enterprise Foundry Co., of Rochester, N. Y., of which he says:

"Most machinists know that cast iron can be made hard. Many of us have seen samples that no file or steel tool would touch. Castings have been known to come that way wholly or in spots when intended to be soft, making the luckless operator wish the work and tools could change places, so as to get a little progress in the right direction. So far as I know, however, little use has been made of hard cast iron, considered as a substitute for steel; our knowledge of its cutting qualities being acquired by trying to work on, rather than with it. * * * * * These cutters are plain iron castings, made in the sand from an ordinary gate pattern, without the use of chills or special devices of any kind—just an ordinary, everyday foundry job in extra hard iron. The only special points necessary to observe in making these castings seem to consist of the management of the heat, the fuel used, the iron selected and the amount of brains mixed with the whole operation. These few things attended to, the castings can be made by anyone that knows how. Most of us find it very easy to get hard castings, even sometimes when not wanted.

"Of course, the iron run into these castings is not that ordinarily produced, most of the work at this foundry having to be extra soft for butts, hinges and other light castings requiring machine work. A special heat is run as often as required to make up a stock of tools; the balance of the iron left over being run into sash-weights, or other castings not requiring machine treatment."

Geo. O. Vair illustrates the method of making chemical pans by skin-drying the mold instead of turning them out in loam as

is often done on this class of work. Speaking of skin-drying molds the author advances the following opinions:

The writer having had considerable experience in this particular branch of the molder's art, would like to add, that judging from the few articles he has read on skin-dried molding, the authors were inclined to convey the idea that much judgment is required in molding, and that the chances for bad results are numerous. The writer's experience in this line of work has been to the contrary. We have had molders make first-class castings by skin-drying, that would have all sorts of trouble on green sand work, simply because it does not require the skill to successfully ram and vent a skin-dried mold that it does to produce good castings in green sand; consequently the extra cost of drying the mold, in a great many cases, is more than offset by the speed in which a skin-dried mold may be rammed up. Where surface nailing has to be resorted to in skin-dried molds, generally speaking, it is safe to say that the sand mixture is at fault. The cost of skin-drying such a mold as the one referred to does not exceed twenty-five cents in this locality, where charcoal is cheap. In regard to the best method of blackening a skin-dried mold, we think the better plan is to rub the blackening on dry by hand and then go over the mold with molasses water, using a camel's hair brush, which is preferable to slicking.

The humidity of the facing sand for skin-dried work should be about the same as is used for green sand work. Molding sand to be of the right nature, for the purpose named, should bake well, that is, it should show no tendency to crumble, or flake off. The following sand mixtures can be depended on to give the very best results, both as to baking and venting free:

10 shovels Gulick's coarse "B" grade, new molding sand.
10 shovels old heap sand.
5 shovels fire sand.
1 to 14 shovels sea coal.
1 to 20 shovels flour.

Wet with thin clay wash. The grade of molding sand mentioned above is procured from Riverside, Pa., and is the best sand the writer ever used for skin-dried molds.

June 8.—C. H. Almond describes an improved method of making small rope sheaves.

June 29.—H. O'Neil, of Dover, N. H., in an article on "Custom versus Reason in the Foundry," writes of the difficulty experienced in introducing new methods.

THE FOUNDRY.

G. D. Rice describes the processes employed in nickel plating and illustrates some of the apparatus needed for this kind of work.

Robert Grimshaw, writing of his experience in German foundries, describes some of the methods employed in that country for making what would ordinarily be termed "stock cores" on this side of the Atlantic.

J. P. Pero contributes an article on "Foundry Management," in which he says:

* * * "I fully believe that to-day many foundries are not half managed; perhaps it would be better to modify this statement and say, rather, that many foundries are managed on false business principles, and it is a conundrum to me how many foundries with whose methods I am more or less familiar manage to continue in business. The only reason I can give for their continuing is this: under the present business conditions there are many men wno must have work at any price; these firms take advantage of this fact and figure the cost of labor very low, because they pay very small wages, and compensate the men for small wages by giving proportionately large days' work. Such firms as this, and there are many of them, are a thorn in the side not only of the molder but of reputable firms who are willing to pay living wages for an honest day's work.

"Probably one of the greatest causes of low prices is in many instances the incompetence of the men who "drum up trade" for the foundries, this is more particularly true of large firms where

the traveling man is some bright fellow who owes his position to the amount of stock owned by his friends, more than to his ability to estimate cost of production in the foundry. He may be and generally is a bright, smart fellow of good appearance, a ready talker and good at making figures, but he lacks the practical knowledge, without which his figures are not reliable. He may know just the cost per pound of the different mixtures of iron, the percentage to be added for non-productive labor freight, maintenance of plant and all the small details of cost except the most important, viz: the cost of productive labor; that is, the cost of the labor of the molder and, perhaps, the coremaker. Imagine a man looking for a contract or a small job on castings who cannot form an idea of the number of castings a man can make in a day or a week, who don't know the amount of time spent by the coremaker on the same work, who don't know whether the casting can be made by the average molder or whether it will require the services of the highest-priced man in the shop, who don't know whether the job will require new flasks or entail considerable expense in adapting old flasks to the job, who is not sufficiently practical to appreciate the difficulty or the simplicity of a casting in the molding, in other words, the liability of loss.

"Do you think such a man competent to make a fair price for castings; perhaps you don't believe there are such people in the business, but there are; this is a strong statement, I am aware, but I know more than one such manager or drummer or anything you want to call him.

"* * * I have know many good managers who were not practical men, but I attribute their success to their good judgment in having associated with them good men in the subordinate positions. In a large concern, doing a large volume of business, such a system of management is thoroughly practical, as the expense of maintaining such a position is proportionately small when charged against a great output and is often more than compensated for by his ability as a financier. I know several foundry firms whose managers are really a constant source of expense for which there is no adequate return, and I have often

wondered that these firms did not abolish the position of manager and substitute an assistant foremanship in the foundry, by so doing give the foreman time to look up work, buy supplies and attend to the practical duties of the manager, while the financial duties might be performed by some of the other officers. Certainly a competent foreman is better able to estimate the cost of labor on work in his line of business than a non-practical man and the office can readily furnish cost of all other items entering into the ultimate cost of the work. I don't mean by this to insinuate that the foundry foreman of to-day isn't able to do all the figuring necessary in getting cost of work (that argument so commonly used a quarter of a century ago now falls flat, thanks to the different trade journals devoting more or less of their space to foundry interests and thanks to the foundrymen who, by educating themselves in all the details of their profession, have done so much to effectually eradicate this slur), but that the cost, outside of actual labor, can be more readily ascertained in the office than in the foundry and not divert the attention of the foreman from the more important duties in the practical part of his work.

"How many managers are as competent to buy supplies as the foreman? Not many; true, the foreman doesn't have time to keep posted on prices, but if buying supplies was one of his duties, he would find it very easy, with the assistance of the office, to be thoroughly acquainted with the latest market reports. And what a difference there would be in the supplies purchased. Have you ever had any experience in a shop where the foundrymen knew nothing of the supplies until they reached the foundry? Have you ever seen the manager come into the foundry with a sample of flux which would entirely do away with dirty castings? Have you ever seen a silver lead sent to the foundry that 'is considerably cheaper than the last but will do just as good work?' Have you ever had the fellow who could save half the fuel in melting, come in and spoil a heat or two for you? Have you ever had a molding machine unloaded on the shop floor and have the manager say, 'there's a machine that can be operated by a laborer and after he gets acquainted with it he can do as much work as

two or three molders'? Have you ever had any experience with the fellow who could throw some substance (the formula of which was a profound secret), into the cupola or a ladle to produce a fine-grained, soft iron from any kind of old scrap? Have you ever had 50 or 100 tons of half-burnt or heavy marine scrap dumped into the yard and been told it was just what you wanted to make castings for which it was entirely unfit? Have you ever had the manager come in with a mixture of the different kinds of pig iron in the yard, to which has been added some strange brand, which predominated to an alarming extent in the mixture, and by the mixture or rather by the prominent factor in the mixture you knew which iron salesman had caught the ear of the manager last." * * *

S. S. Knight writes of "Chill," from which we take the following

* * * "While speaking of the action of chilling irons specially we may consider briefly in the same connection the effect of chilling in general. No chemical difference has ever been detected between the exterior chilled part and the interior unchilled iron of any casting. The phenomenon is due solely to physical rather than to chemical causes. In our previous consideration of the influence of quantities of heat upon chilling, we briefly recognized the potency of the conductivity of the metal in effecting the results. The thermal conductivity of pig metal is roughly proportionate to the graphite carbon which it contains. Hence if the pig metal contained approximately no graphite carbon, the factor of conductivity will tend to augment the chill and consequently, even although white iron melts at a temperature 100 degrees greater than gray iron, yet by its use a far deeper chill may be obtained. The reason for this is obvious in view of the facts that have been stated, because as rapidly as the white iron solidifies, it assumes the temperature of the surface of the mold, and hence acts as a chilling influence upon the adjacent molten iron, which subsequently hardens.

The effect of chilling influences upon castings in general has yet been very little investigated. Cases have frequently come under our observation where castings would exhibit abnormal transverse strength with comparatively small deflection. In many instances this effect was superinduced by the use of new sand, which gives to metal a decidedly closer grain than that which old and tempered sand will to the same iron. This effect may not always be accompanied by a discernible exterior chill, but it will readily be detected when the bars are subjected to machine tests. The results given below were from bars cast in new sand molds, and also from bars poured of the same iron and at the same time into old sand molds. The deflection will be noted especially in the former case and also the breaking strain of the individual bars as compared with their measurements.

BARS CAST IN NEW SAND.

Bar No.	B-k S.	D.	Measurements.
1.....	2,020 lbs.	.25 in.	.985 in.x1.995 in.
2.....	2,115 lbs.	.26 in.	.975 in.x2.000 in.
3.....	2,325 lbs.	.29 in.	1.012 in.x2.010 in.
4.....	2,476 lbs.	.31 in.	.985 in.x2.010 in.
5.....	2,520 lbs.	.33 in.	1.000 in.x2.050 in.
6.....	2,670 lbs.	.34 in.	.995 in.x2.005 in.

BARS CAST IN OLD SAND.

7.....	1,880 lbs.	.35 in.	.975 in.x2.008 in.
8.....	1,905 lbs.	.38 in.	.980 in.x2.015 in.
9.....	1,950 lbs.	.40 in.	1.005 in.x .998 in.
10.....	2,025 lbs.	.44 in.	.985 in.x2.050 in.

While noting the effects of chilling influence caused by the character of the molds we should not alone consider the evidence which machine tests may produce upon transverse bars. It will be noticed that the size of the bar used is such that, roughly speaking, the breaking strain of this one by two inch bar is one-tenth of the tensile strain which a square inch section of the same metal will withstand without disruption. Two bars are therefore given below which will represent the actual tensile strength of a

bar of one inch section which has been freed from exterior scale, thus making the metal subjected to strain uniform throughout.

Bars in New Sand.	Bars in Old Sand.
No. 1—1 sq. in. sec. 26000	1 sq. in. sec. 19000
No. 2—1 sq. in. sec. 25600	1 sq. in. sec. 19500

The discrepancy in the case of bars in new sand will be noticed, and although relatively slight, is yet significant.

While considering the subject of chill, it may be well to approximate accuracy by which silicon may be determined by its measurement. Within the last few years a number of machines have appeared upon the market for the purpose of estimating the amount of silicon by mechanical means. The estimation depends upon two things: First, the chill, and second, the shrinkage of iron. As to how much reliance can be placed upon chill in judging of a silicon content, we have noticed in a previous article. The same figures will also stand in the investigation as to how shrinkage is affected by quantities of silicon. It will readily be seen therefore that neither chill nor shrinkage will even approximately determine the amount of silicon an iron contains. And since by the use of test bars little can be told of the nature of the metal in the casting, we may safely conclude that only such mixtures as are made by analysis will in the long run be economical to iron manufacturers."

IRON MOLDERS' JOURNAL.

C. S. illustrates an emergency method of making steel rings, by substituting segmental cores in place of the usual dried mold. This arrangement was made necessary by the limited capacity of the oven and is not intended in any way to supersede the ordinary practice of molding.

THE TRADESMAN.

In a review of the paper read by Mr. Knight before the convention of the American Foundrymen's Association at Detroit under the title of "The Value of Chemistry in the Foundry," Mr. Keep has the following in The Tradesman of July 15 on "Chemistry and the Foundry":

I see no reason to disagree with any of Mr. Knight's recommendations, though some of them seem impracticable at the present time. He does not seem to understand the extent of the relation between the chemical and physical composition of cast iron. He neglects to state that there is another method than chemical analysis by which the character of cast iron can be controlled.

Mr. Knight says that all founders could afford to employ a chemist, except the smaller ones. This makes it necessary for the manager of a small foundry to employ some less expensive method. He describes the kind of chemist, not simply one able to make determinations, but a metallurgist of practical worth, of judgment and experience, who can apply his knowledge to foundry work.

Men of this kind are rare and command good pay. Mr. Knight doesn't say how much, but I presume that he would consider that they could earn more than $2,000 a year outside the foundry. The cost of chemicals, breakage of apparatus, fuel and assistance would bring the amount at least to $2,500, to which must be added $400, which is Mr. Knight's lowest estimate of first cost of laboratory.

He divides the work of the chemist into two classes:

Analysis of All Products Which Enter the Foundry, Exclusive of Iron.

As he says, much good would result, but only a small portion of these articles depend upon their chemical composition for their usefulness. For example, in selecting sand, facing, flux and brick, analysis would be of benefit, but a single analysis would determine which of those that were within the reach of the founders were best adapted for this special work. It is, however, a fact that each of these materials may give the best satisfaction and yet not conform in composition to an ideal analysis. If good castings are produced with low priced materials the result is just as satisfactory as if they are composed of the ingredients which a chemist would consider most desirable. A paper by Mr. Knight giving his views as to which of these materials are best for certain work and why would be of value to all founders, as

there is no doubt but his opinion would be valuable, but to go over the analytical work necessary to acquire this information in each foundry would seem a poor way to spend money.

The second subject treated is:

Control of a Foundry Iron Mixture by Chemical Analysis.

Mr. Knight looks at this subject from his own standpoint. He assumes that when he knows the chemical composition of the iron which is charged into the cupola, that he knows the composition of the iron which enters the mold, and that he knows from this the physical qualities of the casting. This is the mistake which most chemists make. Those who are practical foundrymen as well as chemists find that a variation of silicon in any individual iron mixture will vary the shrinkage, hardness and brittleness of castings, but that it is not true that a given percentage of silicon, or of all of the other elements, will in different iron mixtures give like physical results.

Strength is more dependent upon size and shape of grain than upon any chemical composition. Of two irons which, by analysis, show exactly the same chemical composition, one may be 50 per cent stronger than the other. For this reason such practical chemists have found it beneficial to measure the physical qualities of their iron as well as to determine the chemical composition.

Mr. Knight says that only two elements can be approximated by physical or mechanical methods. He means carbon and silicon, and it is agreed by all that silicon is the medium by which the founder can change the character of carbon, and by this change the character of the casting. In other words, the mixture is controlled by silicon, which acts on carbon, and these two elements can be approximated by either chemical analysis. Mr. Knight does not seem anxious to acknowledge that there is another method of arriving at exactly the same results that he claims for chemical analysis.

Mechanical Analysis

consists of measuring the physical properties of castings by means of test bars. The measure of shrinkage tells whether

more or less silicon is needed to bring the quality of the casting to an accepted standard of excellence. The measure of the physical quality of a casting shows the combined influence (not the percentage) of each element in the chemical composition, and in addition to this it shows the influence of fuel and of every varying condition attending melting. The latter often affect the physical character of the casting more than the variation in chemical composition.

An increase of silicon will counteract all such influences or the influence of sulphur. A measure of shrinkage tells whether to increase or decrease silicon. A measure of strength tells whether the greatest possible strength has been obtained.

It is better for a founder to employ mechanical analysis and check by as many chemical determinations as he can afford.

Mechanical analysis costs but a few cents each day and takes but a few moments of the foreman's time, and can be used by anyone. Mr. Knight infers that unless irons are mixed according to their ascertained chemical composition the founder must of necessity use high priced irons, and that the only way to use low priced irons is by chemical analysis. Take the case which he cites of an iron which was refused on account of appearance, but which would have made exactly the kind of castings which were required, and the case where the iron looked right but made hard and unsound castings on account of low silicon.

I would have kept enough iron on hand to have maintained substantially a uniform mixture, and would have had the mixture composed of several brands of iron, so that if any one of them should not be exactly what was expected, such change would not materially affect the castings. I would each day measure the shrinkage of a standard size of test-bar, knowing that if the shrinkage was higher than on a previous day the mixture needed more silicon, and that if the shrinkage was lower the iron charged contained more silicon. If I wished to use a new iron I would replace a small portion of the mixture with it. If the new iron contained more silicon than the iron which it replaced the shrinkage would go down. If the good looking iron which

contained only half the silicon that its appearance indicated had been added the increase of shrinkage would have shown that silicon was decreased and that the iron was not economical to use. In such cases I would not use enough of a new iron to alter the general quality of the castings. I said before that the only way to find whether the introduction of an iron into a mixture will increase strength is to break a test bar.

By this method a founder can determine whether a low priced iron is suitable for his use.

It is the small founder that needs help most, for he cannot increase his business unless he can make money while his plant is small.

There is no reason why he should not do better work than his large competitor, because he can watch all details himself.

If we would benefit the founder we must devise simple methods which can be used by all, whether they have had the advantage of a chemical education or not.

The methods must be used by the men now in business without adding to the expense of operating their works.

If any founder is using fluor spar for flux, let him try broken limestone, and he will not need a chemist to show him that it is as good. If he wishes to measure the ash in his coke, let him burn 100 ounces in a stove and weigh the ash. The number of ounces will be the percentage. Mr. Knight thinks that there is not a case where mixtures have been made by chemical analysis and where the method has afterwards been abandoned.

There are many cases where mechanical analysis has been substituted and the laboratory used simply as an accessory.

In writing of "Foundry Facilities," Mr. E. H. Putnam says:

There is also another point that the writer on shop practice would do well to bear in mind, and that is, do not claim too much for improved facilities. If half the various claims set forth in the past year were true, a perfect foundry plant ought to pay several hundred per cent profit—and it won't!

The greatest obstacle to the introduction of improved machinery is the sometimes ridiculous extravagance of the claims made

for it. The production of a casting involves so many different operations, that an improved facility does well if it save even a quarter the amount generally claimed for it. So true is this, that even now, when the margin of profit generally is perhaps less than ever before in the whole history of iron founding, many a foundry whose facilities are meager, and whose operations are performed wholly by hand, successfully competes with the plant whose appointments are of the best.

The trouble is that the advocate of improved methods of production has imbibed too much of the spirit of the politician—he "claims everything!" It will not do always to be changing for the sake of getting something better, though occasionally a change for this purpose is advisable; but when for any reason we do make a change, the utmost pains should be taken to substitute the very best that can be had. And right here is where the man who has kept up with the current literature of his trade has a great advantage over the man who does not read. While it is inadvisable to be always changing for something better, it is nevertheless pitiful to witness the establishment of a new plant without regard to the progress of improvement elsewhere during the period of decadence of the old.

IRON TRADE REVIEW.

We reproduce below an article from the "Iron Trade Review," of July 22, entitled "Foundry Chemistry in Practice":

There is no doubt that in the past four years, since the various foundrymen's associations have taken the question up, there has been a very large increase in the use of chemistry by foundrymen. Not so very long ago, pig iron, as well as all the other supplies used by foundrymen, was purchased entirely by grade. To a large extent consumers of iron still buy it in the same way, but there is a growing inclination to know more of the metalloids. This plan has been furthered by the furnaces to a great extent. Most furnace companies have their own chemical laboratories, which were established primarily for their own use, but which in a number of cases are now used freely by the foundry customers of the furnaces. Comparatively few foundries are large enough to employ

the entire services of a chemist, but many are now in the habit of consulting a chemist when making a mixture of iron. The irons are then bought on a specified chemical analysis, the furnace being under contract to deliver only iron of that analysis. The result of this method is that a foundry is enabled to turn out, day after day, castings of uniform chemical characteristics—insuring uniformity in strength and other physical properties to a much greater degree than if the iron were bought by fracture. It has been found, also, in a number of instances, that in buying iron by analysis it is easier to hold the furnaces to contract than when buying by grade.

One of the large stove manufacturers in Illinois reports that he has had a chemist regularly employed for several years past, although he does not run his own laboratory. This manufacturer makes an analysis of every car of iron for silicon and sulphur, and keeps a general run of all the metalloids. His selection and use of iron are guided entirely by the information thus obtained. The product of the cupolas is sampled every few days, and a complete determination made for silicon, sulphur, manganese, graphitic and combined carbon. This foundryman finds that he cannot afford to neglect any of these elements, and that in the class of castings which he makes he has most need to watch the silicon, sulphur and carbons. Phosphorus, as it is found in the Southern irons, or in a mixture of Northern and Southern irons, generally comes within the limitations without special effort. The same is true of manganese. Regarding the buying of iron, this concern has to say:

"We buy some iron on specifications as to sulphur and silicon, but we have no standards, as we have to take into consideration our actual necessities at the time of purchase. Our purpose, however, is to supply ourselves with stock from which we can make a mixture which will not exceed .03 in sulphur, and not fall below 2.75 in silicon, nor below 3.25 for total carbon; phosphorus, we will say, from .60 to 1.10; manganese, from .40 to 1.00."

One of the largest machinery builders of the country makes the following statements regarding its practice:

"We do all the mixing of irons with the aid of a chemist, having our own laboratory. In most respects we are getting beneficial results, but as we have only been at this work for a year past, we have perhaps not reached the state of perfection which a longer period will develop. We are not always able to produce exactly the results that we desire, but we are approaching it more closely all the time, and by aid of our chemist we are able to do very much better than when we depended on a mixture made from different brands of iron. We are constantly carrying on experiments, and it is our belief that ultimately we shall be able to produce mixtures which will be very close to our needs. The analysis upon which we buy the major portion of our iron is as follows:

Sulphur not to exceed	.05
Phosphorus not to exceed	.40

"This is for our machinery castings. We also buy other grades of iron to mix with same to bring the analysis so as to be suitable for the different grades of casting we are producing. This change with the thickness of the casting and for other conditions, such as iron for chilling, semi-steel, gear iron, etc."

This company has a small experimental cupola, capable of melting up to half a ton of iron, and finds it very useful in testing irons of various chemical constituents and for making tests of mixtures. When any new iron or mixture is to be tried, or any new ideas to be worked out in foundry practice, experiments are made with the small cupola before trying them on a larger scale. It has been found that this method saves a great deal of time and money.

The specifications on which a well-known Western concern, manufacturing harvesting machinery, buys its pig iron are as follows:

"Foundry No. 1.—Under this specification we desire a good, clean iron, as free as possible from dross, kish, etc. The per cent of pig, known as sows, must not vary to any great extent from the usual amount found in a strictly graded No. 1 iron. A clean looking pig, as free as possible from adhering sand, is desirable.

"The chemical constituents should be about as follows: Silicon, not less than 2.50 per cent; sulphur, not to exceed 0.03 per cent; phosphorus, 0.50 to 0.80 per cent; manganese, 0.20 to 0.50 per cent; carbon, 3.50 to 4.00 per cent (about). The three latter constituents will be allowed a slight variation, yet must conform as nearly as possible to the per cent here given.

"Any car of No. 1 foundry pig which shows on analysis less than 2.45 per cent of silicon, or more than 0.033 per cent of sulphur, will be rejected as a No. 1 iron, but if within the limits of No. 2 foundry pig, it may be accepted as such, and paid for according to No. 2 grade price, or if desired, will be returned at expense of shipper.

"Foundry No. 2.—Silicon, not less than 1.90 per cent; sulphur, not to exceed 0.035 per cent; phosphorus, 0.50 to 0.80 per cent; manganese, 0.40 to 1.00 per cent; carbon, 3.50 to 4.00 per cent (about). Any car showing, on analysis, less than 1.85 per cent of silicon, or more than 0.040 per cent sulphur, will be rejected as a No. 2 iron.

"Foundry No. 3.—Silicon, not less than 1.50 per cent; sulphur, not to exceed 0.045 per cent; phosphorus, 0.50 to 0.90 per cent; manganese, 0.40 to 1.20 per cent; carbon, 3.50 to 4.00 per cent (about). An iron showing more than 0.050 per cent of sulphur, will be returned at shipper's expense. In case of dispute, three samplings of the pig will be made, and three separate analyses by three different chemists, the third party to be independent of both buyer and seller."

This company says of the results of its use of chemistry: "We have made our mixture by chemical analysis only for a short time and are not prepared to state the amount of benefit we have derived from it, but we can say that we are very much pleased with this system; have not had a moment's trouble since its adoption."

A Western company whose output is heavy machinery writes The Iron Trade Review as follows:

"We have for several years employed a chemist, having in connection with our works a very complete laboratory, as we

found it greatly to our advantage to know what the analysis of the different irons were that make up our mixtures, and also how the coke analyzed, especially for sulphur. We analyze each car of iron we receive for silicon and sulphur, and occasionally make a complete analysis—that is, for silicon, sulphur, phosphorus, manganese and carbon. Having once determined the phosphorus in a brand of iron, we seldom analyze it again for this, as there is very little variation in it; but it is difficult to determine the silicon and sulphur except by analyzing each car. The foundryman is given the analysis, and makes his mixture on that basis, thus enabling him, where we require a great deal of strength in castings that will have little machining, to run the silicon down to a point that gives the most satisfactory results, or when light castings that require a great deal of machining are wanted, to run the silicon up to any point he wishes.

"We have such a variety of work that our mixtures vary continually, and while we have no absolute specification on which to buy iron, being governed by the market conditions, we at all times insist upon an analysis being furnished us of the iron for which we are negotiating. Then, if it is to our advantage to buy it we can offset its being high or low in silicon by buying an iron at variance with this condition. It would be difficult for us to give an analysis for general foundry practice, as in one heat we will sometimes require several different grades of iron, and have to manage our cupola accordingly. We work almast entirely on the reports of our chemist, and with most satisfactory results."

In its issue of July 29 the same journal has the following as an addition to the former article:

In addition to the data contained in the letters from large foundries in the Central West and Northwest, given in our issue of last week, the following letter will be found an interesting contribution to current comment on the practical application of chemistry to foundry buying and foundry operations. It is from one of the largest concerns in the Northwest engaged in the manufacture of agricultural machinery. The specifications on which it buys pig iron are identical with those printed in last week's article,

as employed by another important company manufacturing for the implement trade. The superintendent of the foundry department gives these additional details concerning the use made of chemical analysis:

"The iron used in our foundry is mixed by analysis, and if care be taken in weighing the pig, coke, etc., the resultant castings are all that could be asked for. We find that with phosphorus and manganese not above our specification, it is necessary to pay attention only to the two metalloids, silicon and sulphur. For small soft castings (i. e., thin plate), we figure 2.50 per cent silicon; for pulleys and unequal castings, 2.35 per cent silicon. For general foundry work, 2.15 to 2.25 per cent of silicon has given the best results, and even pulleys and some very light castings in this mix are excellent.

"Sulphur plays a very important part in mixing by analysis. If above 0.085 per cent the iron begins to be brittle, and at 0.120 per cent it is worthless—at least, our experience has proved this. We aim to keep the sulphur from rising above 0.085 or 0.090 per cent, at most, and usually keep it down to 0.065. As a rule, coke gives 4 per cent of its sulphur to the iron in the cupola. Thus, if the mix figures 0.052 per cent of sulphur in the pig, and the coke 0.75 per cent, we add 4 per cent of $0.75 = 0.030$ to the mix, making the resultant casting $0.052 + 0.030 = 0.082$ per cent sulphur, and an analysis of the castings invariably bears out the rule. It is customary, however, to add 0.030 per cent, no matter if the coke shows less than 0.75 sulphur.

"In cylinders, where a close-grained and medium hard iron is wanted, we aim to have the silicon from 1.30 to 1.75 per cent, and sulphur as low as possible. A cylinder with 1.30 silicon and 0.055 sulphur is quite easily machined, whereas one with the same silicon per cent, but with 0.095 per cent of sulphur invariably works hard.

"Our method of mixing by analysis is quite simple, and the results for the past year are excellent. With the foundry foreman familiar with the analysis method, the castings have run 2.15 per cent silicon, with a variation not to exceed 0.35 per cent, either

way, during the season. Careful mixing and weighing are essential to a uniform iron; also perfect sampling of the pig, coke, flux, etc. When a car of iron is received, it is sampled before unloading. Sometimes as many as 20 pigs are broken before satisfactory samples are obtained. Good sampling is as important as an analysis, perhaps more so, as an analysis of the iron not representing a general average of the car would be misleading. If the car of iron is accepted, it is then unloaded and nicely piled, each pile numbered, and the pile number, car number and date of receiving marked on the envelope used for the borings from the sample pigs. In sampling, an open grain, medium, and a close-grained pig are usually chosen for a sample, the sampler proportioning them according to the amount of each in his judgment. In making the analysis, only two constituents are usually determined, viz.: Silicon and sulphur; although about once a month a complete analysis of each brand is made, in order to note the variation in phosphorus, manganese and carbon.

"In mixing, we allow a loss of 0.15 per cent on silicon. This may vary, however, being influenced by the amount of fuel used and the heat generated.

"In our case, the per cent of loss appears to be about the right figure.

	Silicon.	Cupola Mixture.	
Pig (Pile or brand) No. 1	2.80 per cent	x 40 per cent	= 1.120 %
Pig (Pile or brand) No. 2	2.30 per cent	x 10 per cent	= .230 %
Pig (Pile or brand) No. 3	1.50 per cent	x 05 per cent	= .075 %
Home scrap, Sprues, etc	2.20 per cent	x 30 per cent	= .660 %
Foreign Scrap	1.50 per cent	x 15 per cent	= .225 %
		1.00 per cent	= 2.31
Loss			= .15
Silicon in castings			= 2.16 %

"In a silicon calculation, the required per cent may be determined by allegation or any other suitable method; if the charge is made by per cent, the calculation will be as in the table above.

"Sulphur is estimated in a similar manner, the per cents taken from the analysis card, the brand and pile number being stated as follows:

Calculation of Sulphur.

	Sulphur.	Mixture.	
Pig (Pile or brand) No. 1	0.025 per cent x	40 per cent =	0.01000 %
Pig (Pile or brand) No. 2	.033 per cent x	10 per cent =	.00330 %
Pig (Pile or brand) No. 3	.045 per cent x	05 per cent =	.00225 %
Home scrap, etc.....	.060 per cent x	30 per cent =	.01800 %
Foreign scrap	.095 per cent x	15 per cent =	.01425 %
		100.00 per cent =	.04780
Gain from Coke.....		=	.030
Sulphur in castings.....		=	0.0778 %

"As an example in a cylinder mixture we may take the following:

	Silicon.	Amount in Mixture.	Units.
Pig (Brand) No. 1.....	2.20 per cent x	700 lbs. =	1540.00
Pig (Brand) No. 2.....	1.72 per cent x	1,350 lbs. =	2322.00
Pig (Brand) No. 3.....	1.03 per cent x	500 lbs. =	515.00
Steel Scrap (Rails).....	.05 per cent x	540 lbs. =	22.50
		3,000 lbs. =	4,399.50
1 lb. (4,399.50÷3,000).....		=	1.47 % Sil.
Loss		=	.15
Silicon in cylinder		=	1.32

"Sulphur is calculated in a similar manner. Steel rails generally run 0.095 per cent sulphur.

"The steel rail used in a cylinder mixture is employed to produce a close grained iron. For cylinder meant to be used under very high pressure, the steel may be increased to 25 per cent. In using steel scrap, it becomes necessary to watch the sulphur very closely. I give the following example of calculation:

Calculation of Sulphur in a Cylinder Mixture.

	Sulphur.	Mixture.	Units Sulphur.
Pig (Brand) No. 1	0.012 x	700 lbs. =	11.900
Pig (Brand) No. 2	.028 x	1,350 lbs. =	37.800
Pig (Brand) No. 3	.042 x	500 lbs. =	21.000
Steel rail	.095 x	450 lbs. =	42.950
		3,000 lbs. =	113.650
		1 lb. =	0.03788
Gain from Coke		=	.030
Castings will contain			0.068 Sul.

"In the purchase of coke, we reject any car showing on analysis, more than 0.75 per cent of sulphur.

"In mixing iron by analysis the castings run very uniform. Foundrymen, as a rule, expect the castings to show on analysis the exact per cent figured in the mix. This is an impossibility, as the fuel, the flux, the sampling and weighing are liable to variation. Yet if the work is carefully done the castings should not vary more than 0.50 per cent—generally much less—after the founder gets accustomed to the method."

Guy R. Johnson, in a letter to the Iron Trade Review, speaking of low silicon iron grading as open, says:

"I have seen repeatedly iron down to .5 in silicon grading No. 1 and No. 2, and it is a common thing for us to have on the yard iron running from .50 to .75 in silicon with No. 1 and No. 2 fracture. The whole secret lies in carrying stone enough to slag off the sulphur. The average analysis of such iron would probably show somewhere in the neighborhood of .02 sulphur. Higher than that the iron drifts into No. 3 first and gray forge second. To illustrate the difference I give the analyses of two casts recently shipped from this furnace. The analysis of one was silicon .65, sulphur .019, phosphorus .297, fracturing straight No. 2. The

second cast graded gray forge and gave the following analysis: Silicon .61, sulphur .046, phosphorus .219. Either of these irons will give a heavy chill, as has been repeatedly proved in our foundry here, where we make hundreds of chilled car wheels for mine use every year. Of the two the second is considerably the stronger."